Reported cancer spending in relation to population characteristics, disease burden and service activity for primary care trusts in South East England

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ABSTRACT

Background Since 2000 English cancer policy has directed extra funding towards improving cancer outcomes and quality of care. Few evaluations have related programme budget data on cancer spending to population differences, disease burden, outcome or service activity for cancer. We used existing routine data to explore these associations for 39 primary care trusts (PCTs) in South East England in 2005–2007.

Methods We plotted the cancer spending reported by PCTs in pounds per 100 000 population against measures of population characteristics, disease burden and treatment and hospital activity. We explored associations with PCT size, deprivation, age-standardized cancer incidence and mortality rates, proportions treated with surgery, radiotherapy and chemotherapy and per capita bed days.

Results Lower per capita spending on cancer was associated with smaller PCT populations and a higher proportion of deprived areas within them. Higher spending was associated with higher proportions of radiotherapy treatment and higher per capita hospital bed days for cancer.

Conclusion Cancer spending reported by South East England PCTs does not appear to be related to disease burden, but may relate to treatment and service activity. Models are required to relate possible effects of different expenditures and interventions to improve population outcomes for cancer.

Keyword epidemiology

Introduction

Recent English cancer policy has directed significant extra funding towards improving cancer services and cancer outcomes in England. The National Health Service (NHS) Cancer Plan (2000) set out a national programme aimed at saving lives, ensuring that people with cancer receive the best professional support and increasing investment in the cancer workforce and equipment. The extra funding released was reported to be £570 million in 2003–04, with the actual expenditure reaching £636 million. 520 million pounds were invested in equipment such as CT scanners and linear accelerators, and the number of cancer consultants increased by around 49% from 1997 to 2006. The Cancer Reform Strategy (2007) released a further investment of £370 million by 2010 to focus on prevention, extended screening, faster treatment and services for the increasing numbers of people living with and surviving cancer. An estimated £4.96 billion was spent on cancer services in 2007–08.

Although there was some initial concern that not all the funding allocated by the NHS Cancer Plan to primary care trusts (PCTs) had been received by cancer services, results of a tracking exercise reported in 2005 suggest that it had. In 2004 PCTs were asked to declare the proportion of their budget allocated to major programme areas including cancer. A King's Fund report in 2006 showed some variation in the proportion of the budget for cancer reported by PCTs in 2004–05. Using data reported for 2006–07, the
Cancer Reform Strategy again found considerable variation in the proportion spent by each PCT. The overall distribution ranged from 3.6 to 9.1% of the total PCT budget. The Strategy suggested that some of this variation in the spending might be related to differences in cancer incidence, length of hospital stay and emergency admissions, and recommended that PCTs begin to compare their expenditure to others with similar health needs. Little published evaluation has so far related reported spending to such factors.

Ideally, it might be hoped that a PCT budget for a disease like cancer would be divided into different areas of activity, such as prevention, diagnosis, treatment and supportive and palliative care. Such detailed breakdowns could guide commissioners of cancer services in adjusting the balance of spending depending on problems and priorities identified locally. For example, a high burden of smoking-related cancers would suggest the need for greater investment in prevention programmes, while a high proportion of death in hospitals might suggest the need to develop community palliative care services.

The Thames Cancer Registry (TCR) is the largest cancer registry in England and covers a geographical area of South East England with a population of 12 million. The area includes a wide socioeconomic range and some of the highest national levels of hospital activity. In this study, we used existing routine data sources to explore the association between cancer spending reported by PCTs for 2005–07 and measures of population characteristics, disease burden and treatment and hospital activity. We hypothesized that PCTs with more deprived populations, and those with higher cancer incidence and mortality rates would report higher per capita spending on cancer.

Methods

Data
This analysis used measures derived from five routine sources of data: the Department of Health Programme Budget data sets, the Office for National Statistics population and mortality data sets, the database of the TCR and Hospital Episode Statistics (HES) data. We chose to concentrate on exploring the most recent years of the Programme Budget (2005–07), reasoning that any initial difficulties in identifying expenditure might be expected to have been resolved. We used the 2006 boundaries for 39 PCTs within the current 2010 TCR area.

PCT expenditure
We downloaded data on cancer expenditure for PCTs in our area in 2005–07 from the Department of Health Programme Budget web pages. Data include the raw expenditure reported by PCTs in pounds per 100 000 population, as well as weighted calculations taking into account population needs using an index devised by the Department of Health. We chose to work with the raw expenditure data so that we could relate it more directly to other population-based measures. Input costs in the area of London and South East England are recognized to be around 30% higher than elsewhere in the country. Because our analysis concerns only this area we did not use cost-adjusted figures usually employed when spending is compared nationally. We worked with average per capita figures for the 3 years 2005–07.

Population characteristics
For population characteristics, we used PCT population size data from the Office for National Statistics, and for deprivation level we calculated the percentage based on a small-area geography known as lower super output areas (LSOAs) in each PCT that fell into the most deprived quintiles 4 and 5, assessed using the Income Domain of the Index of Multiple Deprivation 2007. Between 1000 and 3000 people live in a LSOA and the average population is 1500.

Disease burden
For disease burden, we considered population incidence and mortality rates and the absolute numbers of new cases and deaths in each PCT. Because these rates and figures can fluctuate markedly year by year in the relatively small population area covered by some PCTs, we summed and averaged the 3 previous years of data, where possible. From the database of the TCR we extracted the total number of new registrations for malignant neoplasms ICD10 (C00 to C97) for the 3 years 2005–2007. We calculated the age-standardized cancer incidence rate in these years per 100 000 population for each PCT using the European standard population. From the mortality files supplied by the Office for National Statistics, we extracted the total number of deaths in 2005–2007 coded to cancer as the underlying cause of death, and then calculated age-standardized cancer mortality rates using the European standard population.

Treatment and hospital activity
For measures of treatment we extracted data from the registry on residents in each PCT with a record of investigational or cancer surgery, radiotherapy and chemotherapy in the first 6 months of diagnosis and averaged these figures over 3 years. Information on treatment during the study time period was collected from medical records of individual
patients. Data on surgery were mapped by the registry to OPCS4 codes, while registry data for radiotherapy and chemotherapy record simply whether a course of treatment was received or not. Further information and data for those wishing to repeat the analysis are available on request. For measures of hospital activity related to cancer we used the HES data for 2005–2007. From this we extracted the number of bed days for any cancer diagnosis and primary diagnosis in residents of each PCT using the same ICD 10 codes used for the registry data. Bed days may also be regarded as a marker of population co-morbidity.

Analytical methods
We first ranked the expenditures per 100 000 population from highest to lowest PCT and plotted the measures of population size and proportion of LSOAs in deprivation quintiles 4 and 5 alongside. To compare spending with disease burden we plotted both cancer incidence and cancer mortality alongside. These per capita comparisons address the relationship between measures directly and avoid the possibility of confounding by population size. We also looked at number of cases to explore the possibility of some economy of scale within larger PCTs. We then compared per capita expenditure against the proportion of patients receiving different treatments and then with the number of treatments in each PCT. Finally we compared spending per 100 000 population for each PCT with bed days per 100 000 population.

We considered the pattern of the relationships and then quantified the strength of the associations. We used linear regression analysis to model the change in spending for every unit increase in the size of PCT population, level of deprivation, cancer incidence, mortality due to cancer, the proportions of patients with recorded investigative and/or cancer surgery, proportions of patients with recorded chemotherapy, proportion of patients with recorded radiotherapy and number of bed days per 100 000 population. We assessed the relationship between cancer spend and each of these variables using the coefficients of the linear regression. A positive numeric coefficient would indicate an increase in cancer spend per unit increase in the variable. The P-value of each the association is included to determine statistical significance.

Results
PCT characteristics
The reported cancer spend per PCT ranged 3-fold from approximately £4 million to £12 millions per 100 000 population. PCTs with larger populations reported slightly higher per capita spending (Fig. 1a). This relationship was driven by three large PCTs outside London. PCTs with a higher percentage of LSOA in the two most deprived quintiles spent less on cancer (Fig. 1b). Both these association were statistically significant (Table 1).

Disease burden
There appeared to be no relation between per capita cancer spending and population measures of disease burden expressed either as age-standardized incidence rates or as age-standardized mortality rates (Fig. 2). The two measures of disease burden were strongly related to each other. There was also no relationship between per capita spending and the numbers of new cases diagnosed each year or the number of deaths (data not shown). Again the numbers of each of the two events each year were strongly associated.

Treatment and hospital activity
The proportion of newly diagnosed residents undergoing investigative or cancer surgery was not related to reported per capita spending. However, higher reported spending was associated with a higher proportion of patients undergoing radiotherapy in the first 6 months after diagnosis. This finding was statistically significant (Table 1). There was no relationship with the proportion undergoing chemotherapy during this first 6 months (Fig. 3).

The per capita number of bed days coded to cancer diagnoses was related to cancer spending (Fig. 4) and this relationship was statistically significant (Table 1).

Table 1 summarizes the linear regression model and shows that for every increase in the size of the population, cancer spending increased by £2.3 million per 100 000 population and decreased by £28 725 for every increase in the quintile of deprivation. The relationships between cancer spend and incidence rates, mortality rates and proportions of patients with recorded investigative or cancer surgery were not significant. Cancer spend increased by £185 046 for every increase in proportion of patient receiving radiotherapy and increased by around £400 for every unit increase in the number of bed days per 100 000 population.

Discussion
Main findings of this study
In this study we explored the association between average cancer spending reported for 2005–07 by PCTs in South East England and measures of their population characteristics, disease burden and service activity. Contrary to our expectation that PCTs with higher levels of deprivation, and cancer incidence or mortality rates would report higher spending, we found that higher deprivation was associated
with lower spending, and that total disease burden was unrelated to spending. Higher reported spending was associated with a higher proportion of patients receiving radiotherapy in the first 6 months after diagnosis, and with higher per capita bed days for cancer diagnoses. These findings suggest that reported cancer expenditure is inversely or not related to some measures of need, but may be related to aspects of service activity.

**What is already known on this topic**

Previous analyses of cancer expenditure have commented mainly on the range of expenditure across populations rather than attempting to relate this variation to differences in need, outcome or hospital activity. However, one national study by Martin et al. reported a positive relationship between higher PCT expenditure on cancer services in 2005–07 and lower mortality from cancer in
their study included only cancer of the colon and rectum, skin, female breast, cervix, testis and Hodgkin’s disease and leukaemia in their analyses, which they considered amenable to intervention, and adjusted for a number of measures of population need including deprivation. They suggested that their finding provided evidence that increased cancer spending was associated with better health outcomes.10 Cancers such as breast and melanoma of the skin included in the study are more common in affluent areas and have a lower mortality than smoking-related cancers such as lung cancer, which are more common in deprived areas.11 No study has considered variation in spending on all cancers related to incidence, mortality or treatment or hospital activity for cancers and tumours.

What this study adds

In this study we could not confirm our hypotheses that the total PCT expenditure on cancer would be related both to increased population deprivation or disease burden (measured as age-standardized incidence or mortality rates). Despite the well-established association between higher levels of deprivation and higher overall cancer mortality, we found an inverse relationship between cancer spending and deprivation. This may mean that more the deprived PCTs spent less on cancer. We have demonstrated that the variation in overall male cancer mortality in the under 75s in PCTs in South East England is being driven by excess lung cancer mortality in the most deprived PCTs.12 As already noted common cancers with poorer prognoses such as smoking-related cancers, which are less amenable to

Table 1 Linear regression coefficient of cancer expenditure per 100 000 population (average per year, 2005–2007)

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Coefficient (95% CI)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population size (£ per 100 000 population)</td>
<td>2.33 (0.54–4.13)</td>
<td>0.012</td>
</tr>
<tr>
<td>Deprivation (£ per quintile increment in deprivation)</td>
<td>-28725.02 (-39048.77 to -18401.26)</td>
<td>0.000</td>
</tr>
<tr>
<td>Age-standardized incidence rates (£ per 100 000 population, per year)</td>
<td>-854.43 (-13790.63 to 12081.78)</td>
<td>0.894</td>
</tr>
<tr>
<td>Age-standardized mortality rates (£ per 100 000 population, per year)</td>
<td>-4161.97 (-23666.07 to 15342.12)</td>
<td>0.668</td>
</tr>
<tr>
<td>Investigative and/or cancer surgery (£ per extrapolated contrast from 0 to 100%)</td>
<td>36900.90 (-72166.16 to 145968.00)</td>
<td>0.497</td>
</tr>
<tr>
<td>Chemotherapy (£ per extrapolated contrast from 0 to 100%)</td>
<td>73847.18 (-54215.60 to 201910.00)</td>
<td>0.25</td>
</tr>
<tr>
<td>Radiotherapy (£ per extrapolated contrast from 0 to 100%)</td>
<td>185046.30 (81480.77 to 288611.80)</td>
<td>0.001</td>
</tr>
<tr>
<td>Bed days (£ per 100 000 population)</td>
<td>398.59 (65.06 to 732.12)</td>
<td>0.02</td>
</tr>
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Fig. 2 Reported cancer spending and age-standardized incidence and mortality rates for PCTs in South East England per year, 2005–2007.
Fig. 3 Reported cancer spending and proportion of patients receiving first treatments in the first 6 months after diagnosis for resident of PCTs in South East England per year, 2005–2007: (a) investigative and/or cancer surgery; (b) radiotherapy and (c) chemotherapy.
intervention, tend to occur more commonly in deprived populations. It is therefore possible that more deprived PCTs spend less on cancer because the main drivers of spending are the complex and expensive treatments for patients with better prognosis cancers.

The association we found between reported spending and radiotherapy treatment and per capita bed days supports this interpretation, suggesting that the cost of treatment and hospital admissions, and possibly associated co-morbidities may be more influential drivers of overall spending. Patients living in these areas may be more willing or able to undergo these treatments and make more effective demands for them.

In this context, the lack of association between chemotherapy treatment and expenditure is unexpected, but it is possible that the prescription of these treatments later than the first 6 months of diagnosis (as recorded by the cancer registry) or at recurrence would be a more influential driver of spending.

In the long term, more deprived PCTs need to invest more than others in the prevention of smoking-related cancers if they are to decrease their overall cancer mortality rates. Because of the longer time periods involved in the prevention of tobacco-related cancer, it is unrealistic to assume that such spending would translate into decreased mortality rates within several cycles of expenditure. It remains a challenge for commissioners to ensure that expenditure focuses on these long-term goals. There is clearly a need for commissioners in the NHS to understand the drivers of cancer expenditure and for PCTs with similar populations to compare their expenditure against each other as has recently been suggested.\textsuperscript{4} Future research using national data\textsuperscript{13} needs to focus on the different components of expenditure including prevention, treatment and palliative care and develop transparent models to relate the impact of different expenditures and interventions on improving outcomes for cancer in the widest sense (Box).

\textbf{Summary Box}

\textbf{Main findings}

Reported PCT cancer expenditure is unrelated to cancer incidence or mortality.

Smaller PCTs spend less on cancer.

PCTs with higher levels of deprivation spend less on cancer.

PCTs with higher proportions of patients receiving radiotherapy in the first 6 months after diagnosis spend more on cancer.

PCTs with higher per capita cancer bed days spend more on cancer.

\textbf{Possible explanations}

Reported cancer expenditure data are not yet accurate enough to support detailed comparative analyses.

More deprived PCTs have higher proportions of patients with poor prognosis cancers, e.g. lung cancer which is less amenable to treatment. Good prognosis cancers, e.g. breast cancer, are more common in affluent populations and so associated with higher cancer spending.

Patients living in affluent areas are able to demand more treatment.

PCT cancer expenditure is mainly determined by post-6 month treatment patterns, which are in turn determined by socioeconomic patterns of cancer incidence and survival.
Limitations of this study
Our interpretation and discussion makes assumptions about the reliability and validity of the Programme Budget data and the usefulness of analyses based upon it. Although we used the most up-to-date data, when we might have expected initial difficulties in identifying expenditure to be resolved, some inaccuracies in this data may remain. These could be due to difficulties in identifying all cancer expenditures, misclassification of expenditure, for example, when that for a large teaching hospital may be split between adjacent PCTs, or the influence of traditional referral pathways and contracts on patterns of expenditure.14 Cancer registries in the UK do not yet collect information on treatments given at recurrence and it possible that larger differences in this area of care are missing from this analysis. It may be possible to investigate this as data from chemotherapy prescribing databases is integrated into the cancer registration data set. A related issue is that areas with higher cancer prevalence, rather than higher incidence or mortality may have the greater disease burden, which is driving cancer expenditure. Estimates of the number of cancer patients living with cancer in England and are now available for cancer networks and PCTs but were not included in this analyses.15

Contribution
C.O. obtained the data, carried out the analyses and wrote the first outline draft of the paper, H.M. conceived of and designed the study, helped interpret the results and wrote the paper, E.D. helped to design the study, interpret the data and re-drafted all subsequent versions of the paper.

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